Notice No.3

Rules and Regulations for the
Classification of Special Service Craft
July 2018

The status of this Rule set is amended as shown and is now to be read in conjunction with this and prior Notices. Any corrigenda included in the Notice are effective immediately.

Please note that corrigenda amends to paragraphs, Tables and Figures are not shown in their entirety.

Issue date: November 2018

Amendments to	Effective date	IACS/IMO implementation (if applicable)
Part 3, Chapter 5, Section 8	Corrigenda	N/A
Part 5, Chapter 2, Section 2	Corrigenda	N/A
Part 10, Chapter 1, Sections 3, 7 & 9	Corrigenda	N/A

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Part 3, Chapter 5
Anchoring and Mooring Equipment

■   *Section 8*
Anchor windlass design and testing

8.2   Plans and particulars to be submitted

8.2.1   The following plans showing the design specifications, the standard of compliance, engineering analyses and details of construction, as applicable, are to be submitted for evaluation:
*   Windlass foundation drawings ~~inclusive of~~ including the supporting structure below deck. The details shall include bolts, chocks, shear stoppers etc., along with the foot print loads for the specified windlass ratings.
*   Chain stopper foundation drawings ~~inclusive of~~ including the supporting structure below deck. The details shall include bolts, chocks, shear stoppers etc., along with the foot print loads for the specified rating.
*   Windlass arrangement plans showing all the components of the anchoring/mooring system such as the prime mover, shafting, cable lifter, anchors and chain cables; mooring winches, wires and fairleads, if they form part of the windlass machinery, brakes, controls, etc.
*   Dimensions, materials, welding details, as applicable, of all torque-transmitting components (shafts, gears, clutches, couplings, coupling bolts, etc.) and all load-bearing components (shaft bearings, cable lifter, sheaves, drums, bed-frames, etc.) ~~components~~ of the windlass and of the winch, where applicable, including brakes, chain stopper (if fitted), and foundation.
*   Hydraulic system, to include:
    (a)   piping diagram along with system design pressure~~,~~;
    (b)   safety valves arrangement and settings~~,~~;
    (c)   material specifications for pipes and equipment~~,~~;
    (d)   typical pipe joints, as applicable~~, and~~ ;
    (e)   technical data and details for hydraulic motors~~.~~;
    (f)   cooling systems arrangements for hydraulic system oil.

8.3   Materials and fabrication

8.3.1   Materials used in the construction of torque-transmitting and load-bearing parts of windlasses are to comply with LR's *Rules for the Manufacture, Testing and Certification of Materials, July 2018* or an appropriate National or International Standard acceptable to LR, provided that the Standard gives reasonable equivalence to the requirements of LR. The proposed materials are to be indicated in the construction plans and are to be approved in connection with the design. All such materials are to be certified by the material manufacturers and are to be traceable to the manufacturers' certificates.

8.4   Windlass design

8.4.1   In addition to the requirements of the National or International Standard or code of practice acceptable to LR (*see Pt 3, Ch 5, 8.1 General 8.1.2*) the following performance requirements are to be complied with:
(c)   Continuous Duty Pull: The windlass is to have sufficient power to exert a continuous duty pull, Z_{cont1}, over a period of 30 minutes corresponding to the grade and diameter, d_c, of the chain cables as follows:

The anchor masses are assumed to be the masses as given in *Table 5.6.1 Chain cable Equipment - Kedge anchors and wires, towlines and mooring lines*. The value of Z_{cont} is based on the hoisting of one anchor at a time, and ~~also~~ assumes that the effects of buoyancy and hawse pipe efficiency (assumed to be 70 per cent) have been accounted for. In general, stresses in each torque-transmitting component are not to exceed 40 per cent of yield strength (or 0,2 per cent proof stress) of the material under these loading conditions.

8.4.4   The following criteria are to be used for gearing design:
Gears intended to transmit power greater than 100 kW are to be certified by LR, and the gears are to meet the requirements of *Pt 11, Ch 1 Gearing*.

8.6   Alternative windlass design requirements for Special Service Craft for restricted service

8.6.1   Where a chain cable of grade U1 with diameter d_c less than 14 mm is used, the windlass is to have sufficient power to exert, over a period of 30 minutes, a continuous duty pull of:
   $Z_{cont1} = 28,5d_c{}^2$
In all other cases the windlass is to be capable of providing a continuous duty pull as required by *Pt 3, Ch 5, 8.4 Windlass design, 8.4.1(c)*.

8.6.2   Where *Pt 3, Ch 5, 8.6 Alternative windlass design requirements for Special Service Craft for restricted service 8.6.1* applies, the windlass overload capacity is to meet the requirement of the short-term pull as defined in *Pt 3, Ch 5, 8.4 Windlass design 8.4.1(d)* using the continuous duty pull defined in *Pt 3, Ch 5, 8.6 Alternative windlass design requirements for Special Service Craft for restricted service 8.6.1*.

8.7   Hydraulic systems

8.7.1   Hydraulic systems, where employed for driving windlasses, are to comply with the requirements of *Pt 15, Ch 3, 6 Lubricating/hydraulic oil systems*.

8.10   Protection arrangements

8.10.8   The design of the windlass is to be such that the following requirements or equivalent arrangements will minimise the probability of the chain locker or forecastle being flooded in bad weather:
(a)   a weathertight connection can be made between the windlass bedplate, or its equivalent, and the upper end of the chain pipe, by means of a cover or seal., and

8.11   Shop inspection and testing

8.11.1   Windlasses are to be inspected during fabrication at the manufacturers' facilities by a Surveyor for conformance with the approved plans. Acceptance tests, as specified in the specified Standard (*see Pt 3, Ch 5, 8.1 General 8.1.2*), are to be witnessed by the Surveyor and include the following tests, as a minimum:
(b)   Load test. The windlass is to be tested to verify that the continuous duty pull, overload capacity and hoisting speed as specified in *Pt 3, Ch 5, 8.4 Windlass design 8.4.1* can be achieved.
Where the ~~manufacturing~~ manufacturer's works does not have adequate facilities, these tests, including the adjustment of the overload protection, can be carried out on board ship. In these cases, functional testing in the manufacturer's works is to be performed under no-load conditions.

Part 5, Chapter 2
Local Design Loads

■   *Section 2*
Definitions and symbols

2.2   Symbols

2.2.1 L_R, B, D, C_b, L_{WL} and T are as defined in *Pt 3, Ch 1, 6.2 Principal particulars*.

T_x =   local draught measured from the underside of the keel to the operating waterline at the longitudinal position under consideration ~~measured above the baseline is to be taken as the horizontal plane passing though the bottom of the moulded hull at midships,~~ *see Figure 2.2.1 Definition of air gap*

Part 10, Chapter 1
Reciprocating Internal Combustion Engines

■   *Section 3*
Crankshaft design

3.2   Scope

3.2.2   This section uses the ~~static~~ statically determinate method; alternative methods, including a fully documented stress analysis, will be specially considered.

3.2.6   The design of crankshafts is based on an evaluation of safety against fatigue in the highly stressed areas. The calculation is also based on the assumption that the areas exposed to highest stresses are:
(a) fillet transitions between the crankpin and web as well as between the journal and web, ; and
(b) outlets of crankpin oil bores.

3.2.7   When the journal diameter is equal to or larger than the crankpin ~~one~~ diameter, the outlets of main journal oil bores are to be formed in a similar way to the crankpin oil bores, otherwise separate documentation of fatigue safety will be specially considered.

3.2.8 Calculation of crankshaft strength consists initially in determining the nominal alternating bending (*see Pt 10, Ch 1, 3.6 Calculation of bending stresses*) and nominal alternating torsional stresses (*see Pt 10, Ch 1, 3.7 Calculation of torsional stresses*) which~~,~~ when multiplied by the appropriate stress concentration factors (SCF) (*see Pt 10, Ch 1, 3.8 Stress concentration factors*), result in an equivalent alternating stress (uniaxial stress) (*see Pt 10, Ch 1, 3.10 Equivalent alternating stress*). This equivalent alternating stress is then compared with the fatigue strength of the selected crankshaft material (*see Pt 10, Ch 1, 3.11 Fatigue strength*). This comparison will show whether or not the crankshaft concerned is dimensioned adequately (*see Pt 10, Ch 1, 3.12 Acceptability criteria*).

3.2.9 Further information and guidance ~~for~~ on crankshaft design is provided in ~~the~~ LR's *~~Guidance Notes for Crankshaft SCF Calculation using Finite Element Method~~ and ~~Guidance for the Evaluation of Crankshaft Fatigue Tests~~ Guidance Notes for the Calculation of Stress Concentration Factors, Fatigue Enhancement Methods and Evaluation of Fatigue Tests*.

3.3 Information to be submitted

3.3.1 For the calculation of crankshafts, the documents and particulars listed below are required~~, this~~ . This information is provided by completing LR Form 2073 and submitting the applicable plans required in *Table 1.1.1 Plans and particulars to be submitted*:

- ~~Crankshaft~~ crankshaft drawing (which must contain all data in respect of the geometrical configurations of the crankshaft);
- ~~Type~~ type designation and kind of engine (in-line engine or V-type engine with adjacent connecting rods, forked connecting rod or articulated-type connecting rod);
- ~~Operating~~ operating and combustion method (2-stroke or 4-stroke cycle/direct injection, precombustion chamber, etc.);
- number of cylinders;
- ~~Output~~ output power at maximum continuous rating (MCR), in kW;
- ~~Output~~ output speed at maximum continuous power, in rpm;
- ~~Maximum~~ maximum firing pressure, P_{max}, in MPa;
- ~~Mean~~ mean indicated pressure, in MPa;
- ~~Charge~~ change air pressure (before inlet valves or scavenge ports, whichever applies), in MPa;
- ~~Digitised~~ digitised gas pressure/crank angle cycle for MCR (presented at equidistant intervals at least every 5° CA);
- ~~Mean~~ mean piston speed;
- ~~Compression~~ compression ratio;
- ~~Vee~~ vee angle α_v, in degrees;
- ~~Firing~~ firing order numbered from driving end, *see Figure 1.3.1 Designation of cylinders;*
- ~~Direction~~ direction of rotation;
- ~~Cylinder~~ cylinder diameter, in mm;
- ~~Piston~~ piston stroke, in mm;
- ~~Centre~~ centre of gravity of connecting rod from large end centre, in mm;
- ~~Radius~~ radius of gyration of connecting rod, in mm;
- ~~Length~~ length of connecting rod between bearing centres, L_H, in mm;
- ~~Mass~~ mass of single crankweb (indicate if webs either side of pin are of different mass values), in kg;
- ~~Centre~~ centre of gravity of crankweb mass from shaft axis, in mm;
- ~~Mass~~ mass of counterweights fitted (for complete crankshaft) indicate positions fitted, in kg;
- ~~Centre~~ centre of gravity of counterweights (for complete crankshaft) measured from shaft axis, in mm;
- ~~All~~ all individual reciprocating masses acting on one crank, in kg;
- ~~Crankshaft~~ crankshaft material specification(s) (according to ISO, EN, DIN, AISI, etc.);
- ~~Mechanical~~ mechanical properties of material (minimum values obtained from longitudinal test specimens):
  - o tensile strength, in N/mm²
  - o yield strength, in N/mm²
  - o reduction in area at break, percentage
  - o elongation, percentage
- ~~Method~~ method of manufacture (free form forged, continuous grain flow forged, drop-forged, etc., with description of the forging process);
- ~~For~~ for semi-built crankshafts – minimum and maximum diametral interference, in mm; and
- ~~Particulars~~ particulars of alternating torsional stress calculations (*see Pt 10, Ch 1, 3.7 Calculation of torsional stresses*).

3.3.2 The following information is also required for appraisal of the crankshaft (not contained in Form 2073):
- ~~For~~ for engines with articulated-type connecting rod (*see Figure 1.3.2 Articulated-type connecting rod*)~~:~~;
  - o ~~Distance~~ distance to link point L_A, in mm
  - o ~~Link~~ link angle α_N, in degrees
  - o ~~Connecting~~ connecting rod length L_N, in mm
- firing interval (if applicable) i.e. if not evenly distributed;
- ~~Mass~~ mass of connecting rod (including bearings), in kg;
- ~~Mass~~ mass of piston (including piston rod and crosshead where applicable), in kg;
- ~~Every~~ every surface treatment affecting fillets or oil holes shall be specified so as to enable calculation according to Chapter 2 of the LR *Guidance Notes for Crankshaft SCF Calculation using Finite Element Method;*
  - o ~~This~~ this is to include Crankshaft fatigue enhancement factors K_1 and K_2 where applicable.
- ~~Maximum~~ maximum alternating torsional stress τ_A (N/mm²)
- ~~Mechanical~~ mechanical properties of material (minimum values obtained from longitudinal test specimens), in addition to the information listed above:
  Impact energy K_V, in Joules.

3

3.4 Symbols

3.4.1 For the purposes of this Chapter the following symbols apply, *see also*
- *Figure 1.3.3 Crank dimensions for overlapped crankshaft*,
- *Figure 1.3.4 Crank dimensions for crankshaft without overlap*,
- *Figure 1.3.5 Crankpin section through the oil bore*, and
- *Figure 1.3.6 Crankthrow of semi-built crankshaft*

D_{BH} = diameter of axial bore in crankpin, in mm

D_{BG} = diameter of axial bore in journal, in mm

D_G = journal diameter, in mm

Note: For $y \geq 0{,}05 D_S$, where y is less than $0{,}1 D_S$, special consideration is to be given to the effect of the stress due to the shrink fit on the fatigue strength at the crankpin fillet.

σ_{add} = additional bending stress due to misalignment and bedplate deformation as well as due to axial and bending vibrations, in N/mm²

3.6 Calculation of bending stresses

3.6.5 The decisive alternating values will then be calculated according to:
$$X_N = \pm \frac{1}{2}(X_{max} - X_{min})$$

where

X_N is considered as the alternating force, moment or stress

X_{max} is the maximum value within one working cycle

X_{min} is the minimum value within one working cycle.

3.6.9 Alternating bending stresses for the outlet of the crankpin oil bore are calculated as follows:

$$\sigma_{BO} = \pm(\gamma_B \sigma_{BON}) \text{N/mm}^2$$

3.7 Calculation of torsional stresses

3.7.3 Nominal alternating torsional stress is calculated as follows:
$$\tau_N = \pm \frac{M_{TN}}{W_p} \cdot 10^3 \text{ N/mm}^2$$
where
$$M_{TN} = \pm \frac{1}{2}(M_{Tmax} - M_{Tmin}) \text{ Nm}$$
$$W_p = \frac{\pi}{16}\left(\frac{D_G{}^4 - D_{BH}{}^4}{D}\right) \text{ mm}^3 \text{ for the crankpin, or } W_p = \frac{\pi}{16}\left(\frac{D^4 - D_{BG}{}^4}{D_C}\right) \text{ mm}^3 \text{ for the journal}$$

τ_N is to be ascertained from assessment of the torsional vibration calculations where the maximum and minimum torques are determined for every mass point of the complete dynamic system and for the entire speed range by means of a harmonic synthesis of the forced vibrations from the first order up to and including the 15th order for 2-stroke cycle engines and from the 0,5th order up to and including the 12th order for 4-stroke cycle engines. Whilst doing so, allowance must be made for the damping that exists in the system and for unfavourable conditions (misfiring in one of the cylinders when no combustion occurs but only on the compression cycle). The speed step calculation shall be selected in such a way that any resonance found in the operational speed range of the engine shall be detected.

3.8 Stress concentration factors

Table 1.3.2 Crankshaft variable boundaries for analytical SCF calculation

> Notes
>
> Low range The lower bound of s can be extended down to large negative values provided that:
>
> • If calculated f(recess) < 1, then the factor f(recess) is not to be considered (f(recess) = 1)
>
> • If $s < -0{,}5$, then $f(s,w)$ and $f(r,s)$ are to be evaluated replacing actual value of s by $-0{,}5$.

3.11 Fatigue strength

3.11.1 The fatigue strength is to be understood as that value of equivalent alternating stress (Von Mises) which a crankshaft can permanently withstand at the most highly stressed points. The fatigue strength can be evaluated by means of the following formulae:

$$\sigma_{DW} = \pm K(0,42\sigma_B + 39,3)\left[0,264 + 1,073D^{-0.2} + \frac{785-\sigma_B}{4900} + \frac{196}{\sigma_B}\sqrt{\frac{1}{R_X}}\right] \text{N/mm}^2$$

Where a value of K_1 or K_2 greater than unity is to be applied, ~~then~~ details of the manufacturing process are to be submitted. An enhanced K_1 factor will be considered, subject to special approval of the manufacturing specification. *See Materials and Qualification Procedures for Ships, Book E, Procedure MQPS 5-2.*

3.11.3   Fatigue strength calculations or, alternatively, fatigue test results determined by experiment based either on full size crankthrow (or crankshaft), or on specimens taken from a full size crankthrow, may be required to demonstrate acceptability. The experimental procedure for fatigue evaluation of specimens and fatigue strength of crankshaft assessment are to be submitted for approval by LR. The procedure is to include as a minimum: method, type of specimens, number of specimens (or crankthrows), number of tests, survival probability, and confidence number. *See also* LR *Guidance for the Evaluation of Crankshaft Fatigue Tests.*

3.12   Acceptability criteria

3.12.1   The sufficient dimensioning of a crankshaft is confirmed by a comparison of the equivalent alternating stress and the fatigue strength. The acceptability factor, Q, is to be greater than or equal to 1,15 for the crankpin fillet, the journal fillet, and the outlet of crankpin oil bore:

$$Q = \frac{\sigma_{DW}}{\sigma_v}$$

3.13   Shrink fit of semi-built crankshafts

3.13.4   The maximum permissible internal diameter in the journal pin is to be calculated in accordance with the following formula; this condition serves to avoid plasticity in the hole of the journal pin:

$$D_{BG} = D_S\sqrt{1 - \frac{4000S_R M_{max}}{\mu \pi D_S^2 L_S \sigma_{SP}}} \text{ mm}$$

where
S_R = safety factor against slipping; however, a value of not less than 2 is to be taken unless documented by experiments.
M_{max} = absolute maximum value of the torque M_{Tmax} in accordance with *Pt 5, Ch 2, 3.7 Calculation of torsional stresses 3.7.3*, in Nm
μ = coefficient for static friction; however, a value of not greater than 0,2 is to be taken unless documented by experiments.

■ *Section 7*
Control and monitoring of main, auxiliary and emergency engines

7.3   Auxiliary engine governors

7.3.2   If an engine cannot achieve the requirements of *Pt 10, Ch 1, 7.3 Auxiliary engine governors 7.3.1* then the actual load step is to be declared and verified through testing to ensure that the requirements specified in *Pt 16, Ch 2, 1.8 Quality of power supplies* are satisfied. In cases where a step load equivalent to the rated output of a generator is switched off, a transient speed variation in excess of 10 per cent of the rated speed is acceptable, provided that this does not cause the intervention of the overspeed device as required by *Pt 10, Ch 1, 7.4 Overspeed protective devices 7.4.1.*

7.8   Emergency engines

Table 1.7.4 Emergency engines: Alarms and safeguards

Item	Alarm for engine power <220 kW	Alarm for engine power ≥ 220 kW	Note

■ *Section 9*
Starting arrangements

9.4   Additional requirements for electric starting for non-SOLAS cargo vessels

9.4.1   For cargo vessels of less than 500 gross tons which are not required to comply with the SOLAS – International Convention for the Safety of Life at Sea, the emergency source of electrical power may be used as one of the sources of energy required by *Pt 10, Ch 1, 9.3 Electric starting 9.3.1* or *Pt 10, Ch 1, 9.3 Electric starting 9.3.2* for electric starting. Where the emergency source of electrical power is an accumulator battery and it is to be used for electric starting, it is to have the additional capacity required to ensure emergency supplies are not compromised and is to be adequately protected and suitably located for use in an emergency.